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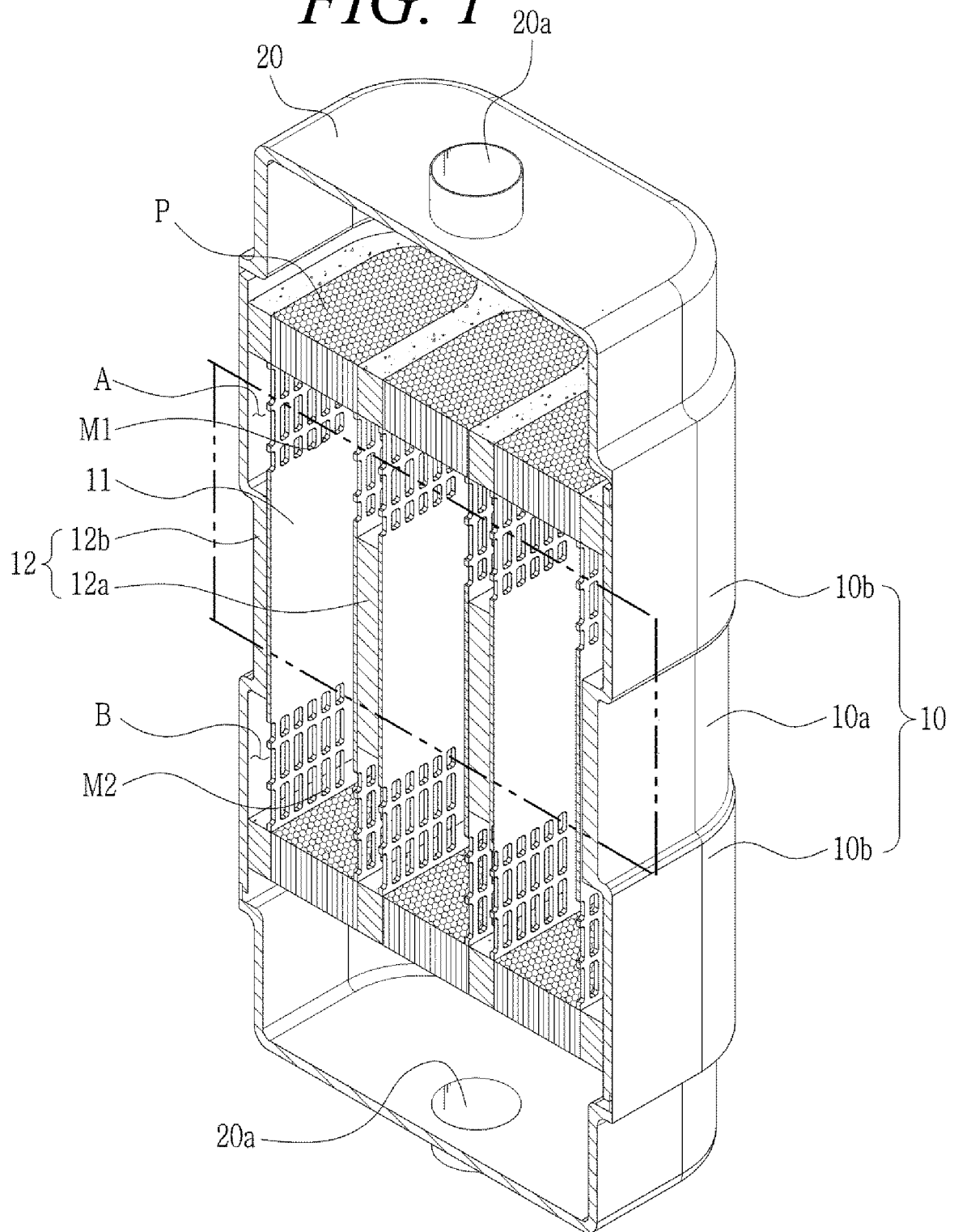
(54) **FUEL CELL MEMBRANE HUMIDIFIER**

(57) The present invention relates to a fuel cell membrane humidifier capable of preventing a humidification efficiency decrease caused by a pressure difference between the inside and the outside of a membrane humidifier. A fuel cell membrane humidifier according to an embodiment of the present invention comprises: a middle case having a module insertion part formed therein; a cap case coupled to the middle case; a hollow fiber mem-

brane module inserted in the module insertion part; and an active pressure buffer part which is formed between the middle case and the module insertion part and prevents expansion of the module insertion part by a pressure difference between the inside and the outside of the middle case according to an output state of a fuel cell or relieves the pressure difference therebetween.

EP 4 266 435 A1

FIG. 1



Description

[Technical Field]

[0001] The present invention relates to a fuel cell membrane humidifier, and more particularly, to a fuel cell membrane humidifier capable of preventing humidification efficiency from being degraded due to a pressure difference between the inside and the outside of a membrane humidifier.

[Background Art]

[0002] Fuel cells are power generation cells that produce electricity through coupling between hydrogen and oxygen. The fuel cells have an advantage of being able to continuously produce electricity as long as the hydrogen and the oxygen are supplied, and having an efficiency that is about twice higher than an internal combustion engine because of no heat loss, unlike general chemical cells such as dry batteries or storage batteries.

[0003] Further, since chemical energy generated through coupling between the hydrogen and the oxygen is directly converted into electrical energy, emission of pollutants is reduced. Therefore, the fuel cells have an advantage of being environmentally friendly and being able to reduce concerns about resource depletion due to increased energy consumption.

[0004] These fuel cells are roughly classified into, for example, a polymer electrolyte membrane fuel cell (PEMFC), a phosphoric acid fuel cell (PAFC), a molten carbonate fuel cell (MCFC), a solid oxide fuel cell (SOFC), and an alkaline fuel cell (AFC) depending on a type of electrolyte used.

[0005] These fuel cells fundamentally operate according to the same principle, but have a difference in a type of fuel used, an operating temperature, a catalyst, an electrolyte, or the like. Among the cells, the polymer electrolyte membrane fuel cell is known to be the most promising not only for small-scale stationary power generation equipment but also for transportation systems because the polymer electrolyte membrane fuel cell operates at a lower temperature than other fuel cells and can be miniaturized due to a high output density.

[0006] One of the most important factors in improving the performance of the polymer electrolyte membrane fuel cell (PEMFC) is to maintain moisture content by supplying a certain amount or more of moisture to a polymer electrolyte membrane (or proton exchange membrane: PEM) of a membrane electrode assembly (MEA). This is because the efficiency of power generation is rapidly degraded when the polymer electrolyte membrane is dried.

[0007] Examples of a method for humidifying the polymer electrolyte membrane include 1) a bubbler humidification scheme for filling a pressure-resistant container with water and then passing a target gas through a diffuser to supply moisture, 2) a direct injection scheme for calculating a moisture supply amount required for a fuel cell reaction and directly supplying moisture to a gas flow pipe through a solenoid valve, and 3) a humidification membrane scheme for supplying moisture to a fluidized gas layer using a polymer separation membrane.

[0008] Among these, the humidification membrane scheme for humidifying a polymer electrolyte membrane by providing water vapor to a gas supplied to the polymer electrolyte membrane using a membrane that selectively permeates only water vapor contained in an off-gas is advantageous in that a weight and size of a humidifier can be reduced.

[0009] A selective permeable membrane used in the humidification membrane scheme is preferably a hollow fiber membrane having a large permeable area per unit volume when a module is formed. That is, when a membrane humidifier is manufactured using hollow fiber membranes, there are advantages that high integration of the hollow fiber membranes with a large contact surface area is possible so that a fuel cell can be sufficiently humidified even with a small capacity, low-cost materials can be used, and moisture and heat contained in an unreacted gas discharged with a high temperature from the fuel cell can be recovered and can be reused through the humidifier.

[0010] Meanwhile, when the membrane humidifier operates, there is a problem in that humidification efficiency is degraded due to a pressure difference between the inside and the outside of the membrane humidifier. This will be described with reference to FIGS. 1, 2, and 3.

[0011] FIGS. 1, 2, and 3 are cross-sectional views of a fuel cell membrane humidifier of the related art. For convenience of description, only hollow fiber membranes in a portion of a potting portion P are illustrated in the drawing, and illustration of hollow fiber membranes of other portions are omitted. In the membrane humidifier of the related art, a hollow fiber membrane module 11 in which a plurality of hollow fiber membranes are accommodated is accommodated inside a middle case 10. As illustrated, the hollow fiber membrane module 11 may be formed in the form of a cartridge. A module insertion portion 12 into which the hollow fiber membrane module 11 in the form of a cartridge is inserted is formed inside the middle case 10. The module insertion portion 12 is formed of a plurality of partition walls 12a and 12b formed inside the middle case 10. Here, the partition wall 12b forming an outer shell of the module insertion portion 12 is substantially a portion of an inner wall of the middle case 10.

[0012] As illustrated in FIG. 2, the hollow fiber membrane module 11 is inserted into the module insertion portion 12 by both sides of the hollow fiber membrane module 11 being put into the partition walls 12a and 12b. In this case, the

middle case 10 includes a central recessed portion 10a of which a central portion is recessed, and an inner wall of the central recessed portion 10a and the hollow fiber membrane module 11 are tightly adhered to each other. As a result, two fluid flow spaces A and B formed by a non-recessed portion 10b of the middle case 10 and the hollow fiber membrane module 11 are isolated from each other. The central recessed portion 10a and the partition wall 12b forming the outer shell of the module insertion portion 12 are substantially the same.

[0013] Meanwhile, a second fluid discharged from a fuel cell stack (not illustrated) flows into the inside through a fluid inlet (not illustrated) formed in the middle case 10 and flows through the hollow fiber membrane module 11 performs moisture exchange with a first fluid supplied from a blower and flowing inside the hollow fiber membranes. A cap case 20 is coupled to the middle case 10, and a fluid inlet 20a through which the first fluid flows into/from the inside is formed in the cap case 20.

[0014] However, in the case of a high-pressure operating condition, that is, when the second fluid flowing into the inside from the fluid inlet (not illustrated) formed in the middle case 10 is a high-pressure fluid having a higher pressure than atmosphere outside the membrane humidifier, a pressure difference occurs between the inside and the outside of the membrane humidifier and the pressure of the second fluid flowing inside the membrane humidifier is higher than external atmospheric pressure, and thus, a pressure gradient is formed toward the outside of the membrane humidifier and a portion of the membrane humidifier (specifically, a recessed portion of the middle case) is deformed in a direction outside the membrane humidifier, as illustrated in FIG. 3. On the other hand, since the internal partition 12a has the same pressure on both sides of the partition, a pressure gradient is not formed and deformation does not occur.

[0015] Change in a shape of the middle case 10 due to the pressure gradient creates a gap between the hollow fiber membrane module 11 and the inner wall of the middle case 10, and the second fluid in a fluid flow space A flows into a fluid flow space B through this gap instead of flowing through the hollow fiber membrane module 11. The second fluid that does not flow through the hollow fiber membrane module 11 is a fluid that has not been humidified through the hollow fiber membranes, which causes a problem in that the humidification efficiency is degraded.

[0016] FIG. 4 is a diagram illustrating another fuel cell membrane humidifier (see Korean Unexamined Patent Publication No. 2019-0138288) of the related art for solving the problems of the fuel cell membrane humidifier of the related art illustrated in FIG. 1.

[0017] As illustrated in FIG. 4, in another fuel cell membrane humidifier of the related art, a module insertion portion 12 and a pressure buffer portion 22 are formed inside a middle case 10. The pressure buffer portion 22 includes a space formed by an outer partition wall 12b and the middle case 10 spaced apart from each other, and a connection portion 21 formed between the outer partition wall 12b and the middle case 10. The connection portion 21 isolates a fluid flow space A from a fluid flow space B so that a fluid flowing into the inside through a fluid passage 20a flows only through a hollow fiber membrane cartridge C.

[0018] The pressure buffer portion 22 configured as described above makes pressure on both sides of the outer partition wall 12b substantially the same. Since a pressure gradient is not formed on both the sides of the outer partition wall 12b due to the pressure buffer portion 22, the outer partition wall 12b is not deformed. Therefore, a gap is not created between the hollow fiber membrane cartridge C and the outer partition wall 12b, unlike the fuel cell membrane humidifier illustrated in FIG. 1, making it possible to prevent the fluid in the fluid flow space A from flowing through the fluid flow space B instead of flowing through the hollow fiber membrane module, and as a result, to prevent the humidification efficiency from being degraded.

[0019] Meanwhile, in the fuel cell membrane humidifier of the related art as illustrated in FIG. 4, when pressure (internal pressure P1) of the second fluid flowing into the inside from a fluid inlet (not illustrated) formed in the middle case 10 is much higher than atmospheric pressure (external pressure P2) outside the membrane humidifier ($P1 \gg P2$) due to a high output situation or an abnormal output situation of a fuel cell, the middle case 10 may receive an outward pressure and expand outward (indicated by E1) due to a pressure difference, as illustrated in FIG. 5A and 5B. In this case, since the outer partition wall 12b is connected to the connection portion 21, the outer partition wall 12b may also expand outward (indicated by E2). When the outer partition wall 12b expands outward, a gap may be created between the hollow fiber membrane cartridge C and the outer partition wall 12b. Therefore, the second fluid that does not flow through the hollow fiber membrane module 11 is generated, which causes a problem in that the humidification efficiency is degraded.

[Disclosure] / [Technical Problem]

[0020] An object of the present invention is to provide a fuel cell membrane humidifier capable of preventing the humidification efficiency from being degraded due to a pressure difference between the inside and the outside of the membrane humidifier.

[Technical Solution]

[0021] A fuel cell membrane humidifier of an embodiment of the invention includes a middle case having a module

insertion portion formed therein; a cap case coupled to the middle case; a hollow fiber membrane module inserted into the module insertion portion; and an active pressure buffer formed between the middle case and the module insertion portion to prevent the module insertion portion from expanding due to a pressure difference between the inside and the outside of the middle case or eliminate a pressure difference, depending on an output situation of a fuel cell.

[0022] In the fuel cell membrane humidifier of the embodiment of the present invention, the module insertion portion may include an outer partition wall formed to be spaced apart from an inner wall of the middle case, and the active pressure buffer portion may include a sliding structure formed between the outer partition wall and the inner wall of the middle case.

[0023] In the fuel cell membrane humidifier of the embodiment of the present invention, the sliding structure may include a first sliding member formed to be fixed to the outer partition wall, protrude in a direction of the middle case, and be spaced apart from the inner wall of the middle case; and a second sliding member formed on the inner wall of the middle case and formed to protrude in a direction of the outer partition wall and be spaced apart from the outer partition wall.

[0024] The fuel cell membrane humidifier of the embodiment of the present invention may include: a bypass hole formed in at least one of the first sliding member and the second sliding member, the bypass hole being able to be opened or closed depending on a magnitude of expansion pressure between the outer partition wall and the middle case.

[0025] In the fuel cell membrane humidifier of the embodiment of the present invention, the first sliding member and the second sliding member may include sliding protrusions protruding in opposite directions.

[0026] In the fuel cell membrane humidifier of the embodiment of the present invention, a sliding space may be formed between the sliding protrusion of the first sliding member and the sliding protrusion of the second sliding member.

[0027] In the fuel cell membrane humidifier of the embodiment of the present invention, when the middle case expands outward, the second sliding member may expand outward together with the middle case, and the first sliding member may remain fixed to the outer partition wall.

[0028] In the fuel cell membrane humidifier of the embodiment of the present invention, the hollow fiber membrane module may include at least one hollow fiber membrane bundle in which a plurality of hollow fiber membranes are integrated or at least one hollow fiber membrane cartridge in which a plurality of hollow fiber membranes are accommodated.

[0029] Other specific matters of implementation examples of various aspects of the present invention are included in the detailed description below.

[Advantageous Effects]

[0030] According to an embodiment of the present invention, it is possible to prevent the humidification efficiency from being degraded due to a pressure difference between the inside and the outside of the membrane humidifier. Further, it is possible to prevent a gap from being created between a hollow fiber membrane cartridge and an outer partition even in a high output situation or an abnormal output situation of a fuel cell to prevent the humidification efficiency from being degraded.

[Description of Drawings]

[0031]

FIGS. 1, 2, and 3 are views showing problems of a fuel cell membrane humidifier of the related art.

FIG. 4 is a view illustrating another fuel cell membrane humidifier of the related art for solving the problems of the fuel cell membrane humidifier of the related art illustrated in FIG. 1.

FIG. 5A and 5B are a view illustrating problems of the other fuel cell membrane humidifier according to related art illustrated in FIG. 4.

FIGS. 6, 7, 8 and 9 are views illustrating various types of fuel cell membrane humidifiers of an embodiment of the present invention.

FIG. 10 is a cross-sectional view illustrating a portion of a middle case of the fuel cell membrane humidifier according to the embodiment of the present invention.

FIGS. 11 and 12 are enlarged cross-sectional views of a first embodiment of a sliding structure, which is a component of an active pressure buffer portion of the fuel cell membrane humidifier according to the embodiment of the present invention.

FIGS. 13 and 14 are enlarged cross-sectional views of a second embodiment of the sliding structure, which is the component of the active pressure buffer portion of the fuel cell membrane humidifier according to the embodiment of the present invention.

FIG. 15 is a cross-sectional view illustrating an operating state of the fuel cell membrane humidifier according to the

embodiment of the present invention.

[Mode for Disclosure]

[0032] Since various changes may be made to the present invention, which may have several embodiments, specific embodiments will be illustrated and described in detail herein. However, it will be understood that this is not intended to limit the present invention to the specific embodiments, and all changes, equivalents, or substitutions included in the spirit and scope of the present invention are included.

[0033] The terms used herein are for the purpose of describing specific embodiments only and are not intended to limit the present invention. The singular forms "a," "an" and "the" include the plural forms, unless the context clearly indicates otherwise. It will be understood that the terms "comprises," "comprising," "includes" and/or "including," herein specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. Hereinafter, a fuel cell membrane humidifier according to embodiments of the present invention will be described with reference to the drawings.

[0034] FIGS. 6, 7, 8 and 9 are views illustrating various types of fuel cell membrane humidifiers of an embodiment of the present invention. As illustrated in FIGS. 6, 7, 8 and 9, the fuel cell membrane humidifier (hereinafter also referred to as a 'membrane humidifier') of the embodiment of the present invention includes a middle case 110 and a cap case 120.

[0035] The middle case 110 is combined with the cap case 120 to form an outer shape of the membrane humidifier. The middle case 110 and the cap case 120 may be made of hard plastic such as polycarbonate or metal. The middle case 110 and the cap case 120 may have a polygonal cross-sectional shape in a width direction, as illustrated in FIGS. 6 and 7. The polygon may be a quadrangle, a square, a trapezoid, a parallelogram, a pentagon, a hexagon, or the like, and the polygon may have a shape with rounded corners. Alternatively, the cross-sectional shape in the width direction may be a circular shape, as illustrated in FIGS. 8 and 9. The circular shape may be an elliptical shape. FIGS. 6, 7, 8

and 9 illustrate only examples of the shape of the membrane humidifier, but the present invention is not limited thereto. **[0036]** In the middle case 110, a second fluid inlet 111 through which the second fluid is supplied, and a second fluid outlet 112 through which the second fluid is discharged are formed, and a hollow fiber membrane module F in which a plurality of hollow fiber membranes are accommodated is disposed inside the middle case 110. Depending on a design, reference sign 111 may denote the second fluid outlet through which the second fluid is discharged, and reference sign 112 may denote a second fluid inlet through which the second fluid is supplied. That is, one of reference signs 111 and 112 may denote the second fluid inlet, and the other may denote the second fluid outlet. In the following description, an example in which reference sign 111 denotes the second fluid inlet and reference sign 112 denotes the second fluid outlet will be described, but the present invention is not limited thereto.

[0037] The hollow fiber membrane module F may be a hollow fiber membrane bundle in which a plurality of hollow fiber membranes are integrated as illustrated in FIGS. 7 and 9, or may be hollow fiber membrane cartridges in which hollow fiber membranes or hollow fiber membrane bundles are accommodated as illustrated in FIGS. 6 and 8. A case in which a plurality of hollow fiber membrane cartridges form the hollow fiber membrane module F is illustrated in FIGS. 6 and 8, the present invention is not limited thereto, and the hollow fiber membrane module F may be formed of one hollow fiber membrane cartridge. In the following description, an example in which the hollow fiber membrane module F is formed of a plurality of cartridges C illustrated in FIG. 6, and a membrane humidifier has a polygonal cross-sectional shape in a width direction will be described, but substantially the same can apply to a membrane humidifier in FIGS. 7, 8 and 9. Further, a case in which a shape of the cartridge C also has a circular or rectangular cross section is illustrated, but the shape of the cartridge C is not limited thereto.

[0038] The cap case 120 is coupled to both ends of the middle case 110. Fluid passages 121 are formed in the respective cap cases 120, one of which becomes a first fluid inlet and the other one becomes a first fluid outlet. The first fluid flowing into the fluid passage 121 of the cap case 120 on one side passes through an inner duct of the hollow fiber membranes accommodated in the hollow fiber membrane cartridge (C, see FIG. 1), and then, exits through the fluid passage 121 of the cap case 120 on the other side. The hollow fiber membrane is, for example, a hollow fiber membrane of a Nafion, polyetherimide, polyphenylsulfone, polyimide (PI), polysulfone (PS), or polyethersulfone (PES) material.

[0039] A first mesh portion (M1, FIG. 1) causing the second fluid flowing into the membrane humidifier through the second fluid inlet 111 to flow into the hollow fiber membrane cartridge is formed at one end of the hollow fiber membrane cartridge C, and a second mesh unit (M2, FIG. 1) causing the second fluid that has performed moisture exchange inside the hollow fiber membrane cartridge to flow to the outside of the hollow fiber membrane cartridge may be formed at the other end. Both sides of the hollow fiber membrane cartridge C are inserted into a module insertion portion 210 by being put into partition walls 211 and 212 (FIG. 10). Further, locking jaws (not shown) may be selectively formed on both the sides of the hollow fiber membrane cartridge, and when the hollow fiber membrane cartridge is inserted into the module insertion portion 210, the locking jaws may be put into the partitions walls 211 and 212 forming the module insertion portion 210.

[0040] Potting portions P that fill gaps between the hollow fiber membranes while binding the hollow fiber membranes are formed at both ends of the hollow fiber membrane cartridge or the hollow fiber membrane bundle. Thus, both ends of the hollow fiber membrane module are closed by the potting portions P, and a flow path through which the second fluid passes is formed therein. A material of the potting portion is well known, and detailed description thereof is omitted herein. A resin layer E with which a gap between the potting portion P and the middle case 110 is filled may be formed around the potting portion P, or a gasket assembly (not illustrated) that airtightly couples the potting portion P to the middle case 110 through mechanical assembly may be formed around the potting portion P.

[0041] FIG. 10 is a cross-sectional view illustrating a portion of a middle case of the fuel cell membrane humidifier of the embodiment of the present invention. As shown in FIG. 10, the module insertion portion 210 and an active pressure buffer portion 220 are formed inside the middle case 110.

[0042] The hollow fiber membrane cartridge C in which the plurality of hollow fiber membranes are accommodated is inserted into the module insertion portion 210. The module insertion portion 210 is made of a plurality of partition walls 211 and 212 so that the plurality of hollow fiber membrane cartridges C can be inserted. Meanwhile, when the hollow fiber membrane module F includes a single hollow fiber membrane cartridge, the inner partition wall 211 may be omitted. In this case, the module insertion portion 210 may be formed of only an outer partition wall 212.

[0043] An inner wall 110a of the middle case is formed to be spaced apart from the partition wall 212 forming an outermost shell of the module insertion portion 210. A space S created by the outer partition wall 212 and the inner wall 110a of the middle case being formed to be spaced apart from each other forms the active pressure buffer portion 220. The active pressure buffer portion 220 may further include a sliding structure 221 formed between the outer partition wall 212 and the inner wall 110a of the middle case.

[0044] The active pressure buffer portion 220 may be formed over a circumference of the outer partition wall 212. The active pressure buffer portion 220 isolates the fluid flow space A from the fluid flow space B so that the fluid flows only through the hollow fiber membrane cartridge C.

[0045] Further, the sliding structure 221, which is one component of the active pressure buffer portion 220, can prevent the outer partition wall 212 from expanding outward due to a pressure difference to prevent the humidification efficiency from being degraded even when pressure (internal pressure P1) of the second fluid flowing into the inside through the fluid inlet 111 formed in the middle case 110 is much higher than atmospheric pressure (external pressure P2) outside the membrane humidifier due to a high output situation or an abnormal output situation of the fuel cell.

[0046] Hereinafter, a first embodiment of the sliding structure 221 will be described with reference to FIGS. 11 and 12. FIGS. 11 and 12 are enlarged cross-sectional views of the first embodiment of the sliding structure 221, which is one component of the active pressure buffer portion 220.

[0047] As illustrated in FIGS. 11 and 12, the sliding structure 221 includes a first sliding member 221a and a second sliding member 221b. The first sliding member 221a is formed to be fixed to the outer partition wall 212, protrude toward the middle case 110, and be spaced apart from the inner wall 110a of the middle case 110. The second sliding member 221b is formed on the inner wall 110a of the middle case 110 and is formed to protrude in a direction of the outer partition wall 212 and be spaced apart from the outer partition wall 212.

[0048] The first sliding member 221a and the second sliding member 221b include sliding protrusions 221aa and 221ba protruding in opposite directions, and a sliding space SS is formed between the two sliding protrusions 221aa and 221ba.

[0049] The pressure of the second fluid in the high output situation of the fuel cell is relatively higher than that in the low output situation. Further, the pressure of the second fluid in the abnormal output situation of the fuel cell is relatively higher than that in the normal output situation.

[0050] When the pressure of the second fluid is relatively higher in the high output situation or the abnormal output situation of the fuel cell, the middle case 110 receives an outward pressure due to a large pressure difference and expands outward (indicated by E1). In this case, the second sliding member 221b formed in the middle case 110 expands outward together with the middle case 110, and the sliding space SS gradually decreases. When the high output situation or the abnormal output situation continues or further worsens, the pressure of the second fluid may further increase, the two sliding protrusions 221aa and 221ba may come into contact with each other, and the sliding space SS may temporarily disappear. The first sliding member 221a remains fixed to the outer partition wall 212 until the sliding space SS disappears (see FIG. 12).

[0051] Thereafter, when the high output situation or the abnormal output situation is eliminated, that is, when the fuel cell returns to the low output situation or the normal output situation, the pressure of the second fluid becomes relatively lower, and thus, the expansion pressure gradually decreases and the second sliding member 221b returns to the direction of the outer partition wall 212. Accordingly, the sliding space SS returns to an original state. (see FIG. 11)

[0052] The active pressure buffer portion 220 configured as described above allows the pressure on both sides of the outer partition wall 212 to be maintained substantially the same even when the output situation of the fuel cell is an abnormal output situation in which abnormal pressure is generated. Since a pressure gradient is not formed on both the sides of the outer partition wall 212 due to the active pressure buffer portion 220, the outer partition wall 212 is not deformed.

[0053] Next, a sliding structure 221' of a second embodiment will be described with reference to FIGS. 13 and 14. FIGS. 13 and 14 are enlarged cross-sectional views illustrating the second embodiment of the sliding structure, which is one component of the active pressure buffer portion 220.

[0054] As illustrated in FIG. 13, the sliding structure 221' includes a first sliding member 221a and a second sliding member 221b, similar to the sliding structure 220 of the first embodiment described above, and in the present embodiment, the first sliding member 221a and the second sliding member 221b further include bypass holes 221ab and 221bb. The bypass holes 221ab and 221bb may be opened or closed depending on a magnitude of expansion pressure between the first sliding member 221a and the second sliding member 221b.

[0055] For example, when the sliding space SS is relatively large because the expansion pressure between the first sliding member 221a and the second sliding member 221b is not high, the bypass holes 221ab and 221bb are closed by the sliding members 221a and 221b (see FIG. 13).

[0056] The pressure of the second fluid in the high output situation is relatively higher than that in the low output situation of the fuel cell. Further, the pressure of the second fluid in the abnormal output situation is relatively higher than the normal output situation of the fuel cell.

[0057] When the pressure of the second fluid is relatively higher in the high output situation or the abnormal output situation of the fuel cell, the middle case 110 receives an expansion pressure due to a large pressure difference and expands outward (indicated by E1). In this case, the second sliding member 221b formed in the middle case 110 expands outward together with the middle case 110, and the sliding space SS gradually decreases.

[0058] When the high output situation or the abnormal output situation continues or further worsens, the pressure of the second fluid further increases and the sliding space SS further decreases so that the bypass holes 221ab and 221bb closed by the sliding members 221a and 221b are open as an opening gradually increases (see FIG. 14)

[0059] When the bypass holes 221ab and 221bb are open as in FIG. 14, the fluid in the fluid flow space A flows into the fluid flow space B through the bypass holes 221ab and 221bb, and then, is discharged through the second mesh portion M2 and the second fluid outlet 112, thereby eliminating the pressure of the fluid flowing in the fluid flow space A.

[0060] Thereafter, when the high output situation or the abnormal output situation is eliminated, that is, when the fuel cell returns to the low output situation or the normal output situation, the pressure of the second fluid becomes relatively lower, and thus, the expansion pressure gradually decreases and the second sliding member 221b returns to the direction of the outer partition wall 212. Accordingly, the sliding space SS returns to an original state, and the bypass holes 221ab and 221bb are closed again, making it possible to prevent the fluid in the fluid flow space A from flowing through the fluid flow space B instead of flowing through the hollow fiber membrane module F.

[0061] The active pressure buffer portion 220 configured as described above can prevent a gap from being created between the hollow fiber membrane cartridge and the outer partition wall or eliminate a pressure difference even in a high output situation or an abnormal output situation of the fuel cell, thereby preventing the humidification efficiency from being degraded.

[0062] In connection thereto, referring to FIG. 15, the hollow fiber membrane cartridge C is disposed between the inner partition walls 211, and the second fluid discharged from the fuel cell stack (not illustrated) and flowing into the second fluid inlet 111 flows into the cartridge C through the first mesh portion M1, performs moisture exchange while flowing outside the hollow fiber membranes, and then, flows to the outside of the cartridge through the second mesh portion M2. In this case, since the pressure P1 of the fluid flowing through the hollow fiber membrane cartridge C is the same, the pressures on both the sides of the inner partition wall 211 are balanced so that no deformation occurs.

[0063] Meanwhile, in the outer partition wall 212, the second fluid at high pressure P1 flows through the hollow fiber membrane cartridge C on one side, and the second fluid at high pressure P1' that does not flow through the hollow fiber membrane cartridge C flows on the other side. Since the second fluids flowing through both the sides of the outer partition wall 212 have substantially the same pressure ($P1 = P1'$), the pressures on both the sides of the outer partition wall 212 are balanced so that no deformation occurs.

[0064] Meanwhile, when a pressure difference between the pressure P1 of the second fluid flowing through the active pressure buffer portion 220 and the atmospheric pressure P2 outside the middle case 110 is large in the high output situation or the abnormal output situation of the fuel cell, the second sliding member 221b of the sliding structure 221 only expands outward together with the middle case 110, and the first sliding member 221a remains fixed to the outer partition wall 212. Thus, airtightness between the outer partition wall 212 and the hollow fiber membrane cartridge C is maintained, and the second fluid does not leak between the outer partition wall 212 and the hollow fiber membrane cartridge C.

[0065] Meanwhile, the second fluid flowing into the active pressure buffer portion 220 is turned in the sliding structure 221 and then, flows into the hollow fiber membrane cartridge C.

[0066] Therefore, no gap is created between the hollow fiber membrane cartridge C and the outer partition wall 212 even in the high output situation or the abnormal output situation of the fuel cell unlike the related art, making it possible to prevent the fluid in the fluid flow space A from flowing through the fluid flow space B instead of flowing through the hollow fiber membrane module F, and as a result, to prevent the humidification efficiency from being degraded.

[0067] Further, when the high output situation or the abnormal output situation continues or further worsens, the pressure of the second fluid further increases and the sliding space SS further decreases so that the bypass holes 221ab and 221bb closed by the sliding members 221a and 221b are open as an opening gradually increases (see FIG. 14). When the bypass holes 221ab and 221bb are open, the fluid in the fluid flow space A flows into the fluid flow space B through the bypass holes 221ab and 221bb, and then, is discharged through the second mesh portion M2 and the second fluid outlet 112, thereby eliminating the pressure of the fluid flowing in the fluid flow space A.

[0068] Although the embodiment of the present invention has been described above, those skilled in the art can variously modify or change the present invention through affixation, change, deletion, addition, or the like of components without departing from the concept of the invention described in the claims, and this will be said to be also included within the scope of the present invention. 221ab, 221bb: bypass hole

[Description of code]

[0069]

110:	middle case portion	220:	active pressure buffer	221ab, 221bb:	bypass hole
120:	cap case	221:	sliding structure	SS:	sliding space
210:	module insertion portion	221a:	first sliding member cartridge	A, B:	fluid flow space
211:	inner partition wall	221b:	second sliding member	C:	hollow fiber membrane
212:	outer partition wall	221aa, 221ba:	sliding protrusion module	F:	hollow fiber membrane

Claims

1. A fuel cell membrane humidifier comprising:

a middle case having a module insertion portion formed therein;
a cap case coupled to the middle case;
a hollow fiber membrane module inserted into the module insertion portion; and
an active pressure buffer formed between the middle case and the module insertion portion to prevent the module insertion portion from expanding due to a pressure difference between the inside and the outside of the middle case or eliminate a pressure difference, depending on an output situation of a fuel cell.

2. The fuel cell membrane humidifier of claim 1, wherein the module insertion portion includes an outer partition wall formed to be spaced apart from an inner wall of the middle case, and the active pressure buffer portion includes a sliding structure formed between the outer partition wall and the inner wall of the middle case.

3. The fuel cell membrane humidifier according to claim 2, wherein the sliding structure includes:

a first sliding member formed to be fixed to the outer partition wall, protrude in a direction of the middle case, and be spaced apart from the inner wall of the middle case; and
a second sliding member formed on the inner wall of the middle case and formed to protrude in a direction of the outer partition wall and be spaced apart from the outer partition wall.

4. The fuel cell membrane humidifier of claim 3, comprising a bypass hole formed in at least one of the first sliding member and the second sliding member, the bypass hole being able to be opened or closed depending on a magnitude of expansion pressure between the outer partition wall and the middle case.

5. The fuel cell membrane humidifier of claim 3, wherein the first sliding member and the second sliding member include sliding protrusions protruding in opposite directions.

EP 4 266 435 A1

6. The fuel cell membrane humidifier of claim 5, wherein a sliding space is formed between the sliding protrusion of the first sliding member and the sliding protrusion of the second sliding member.
7. The fuel cell membrane humidifier of claim 3, wherein, when the middle case expands outward, the second sliding member expands outward together with the middle case, and the first sliding member remains fixed to the outer partition wall.
8. The fuel cell membrane humidifier of any one of claims 1 to 7, wherein the hollow fiber membrane module includes at least one hollow fiber membrane bundle in which a plurality of hollow fiber membranes are integrated or at least one hollow fiber membrane cartridge in which a plurality of hollow fiber membranes are accommodated.

FIG. 1

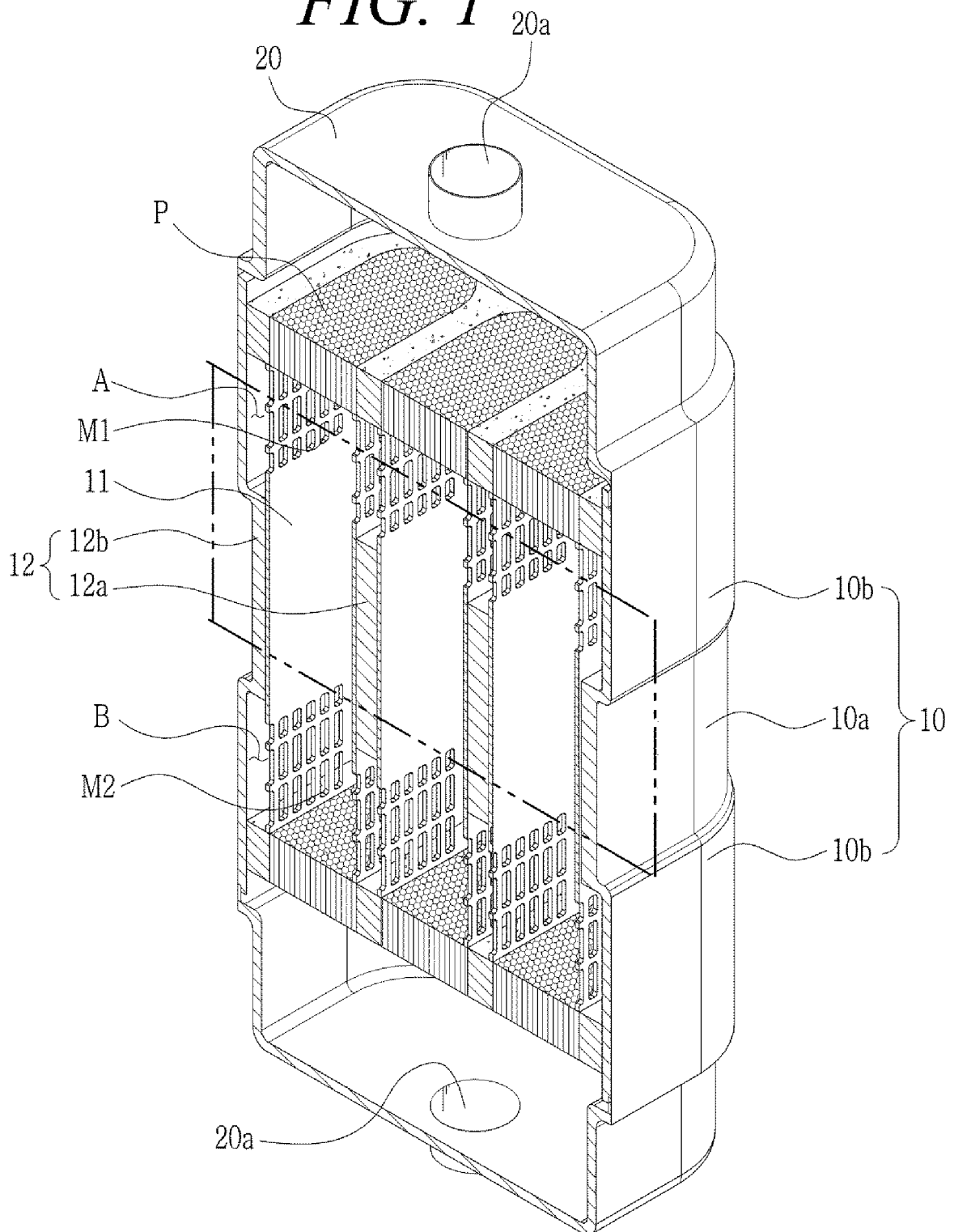


FIG. 2

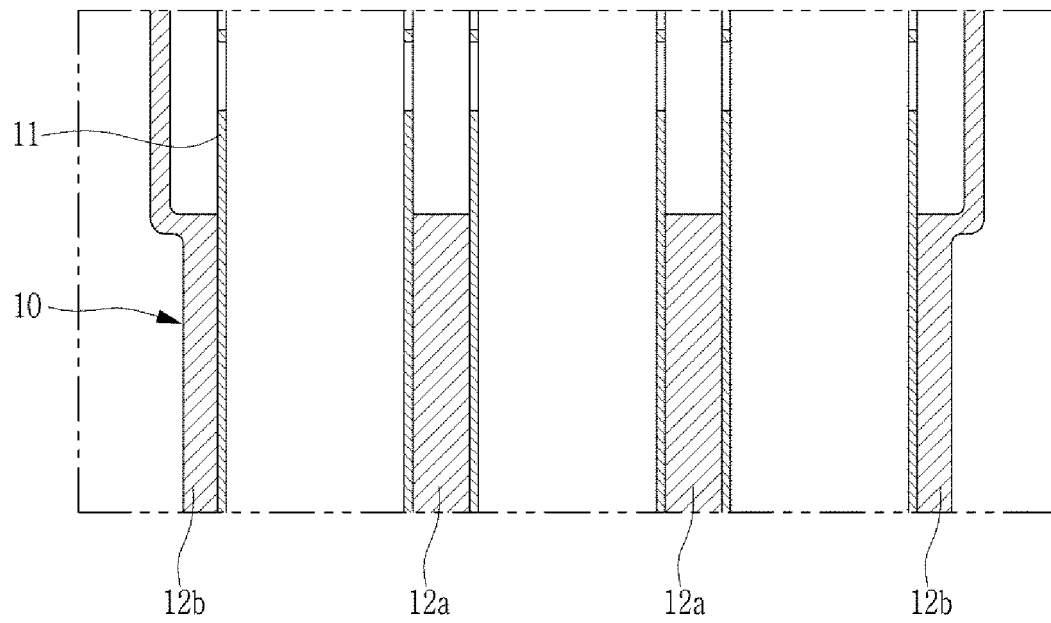


FIG. 3

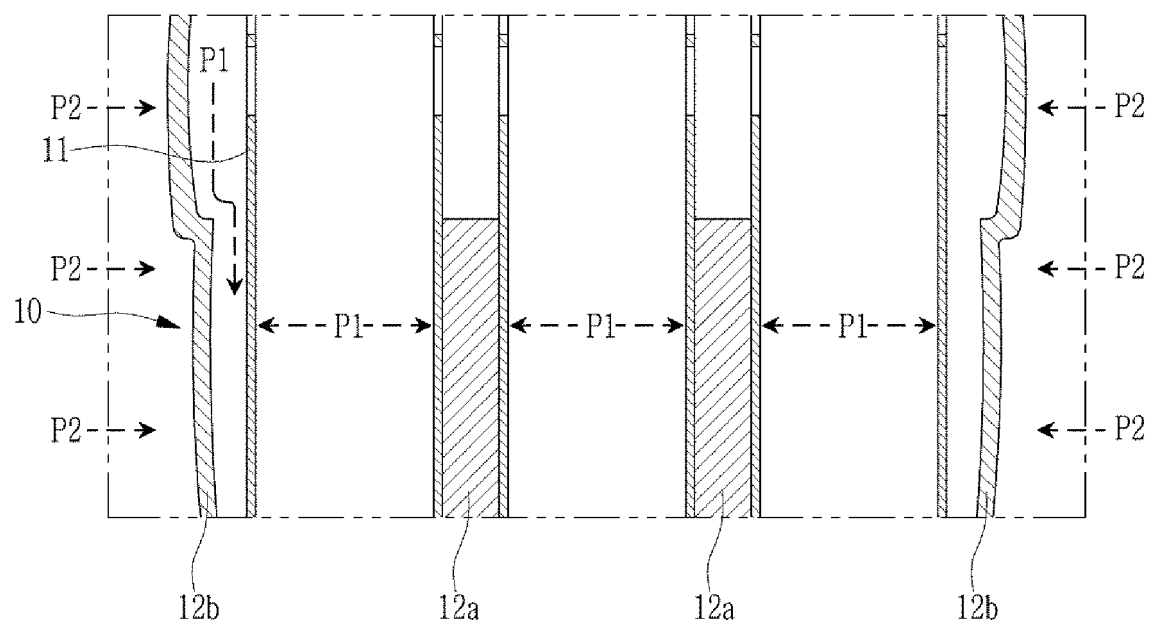


FIG. 4

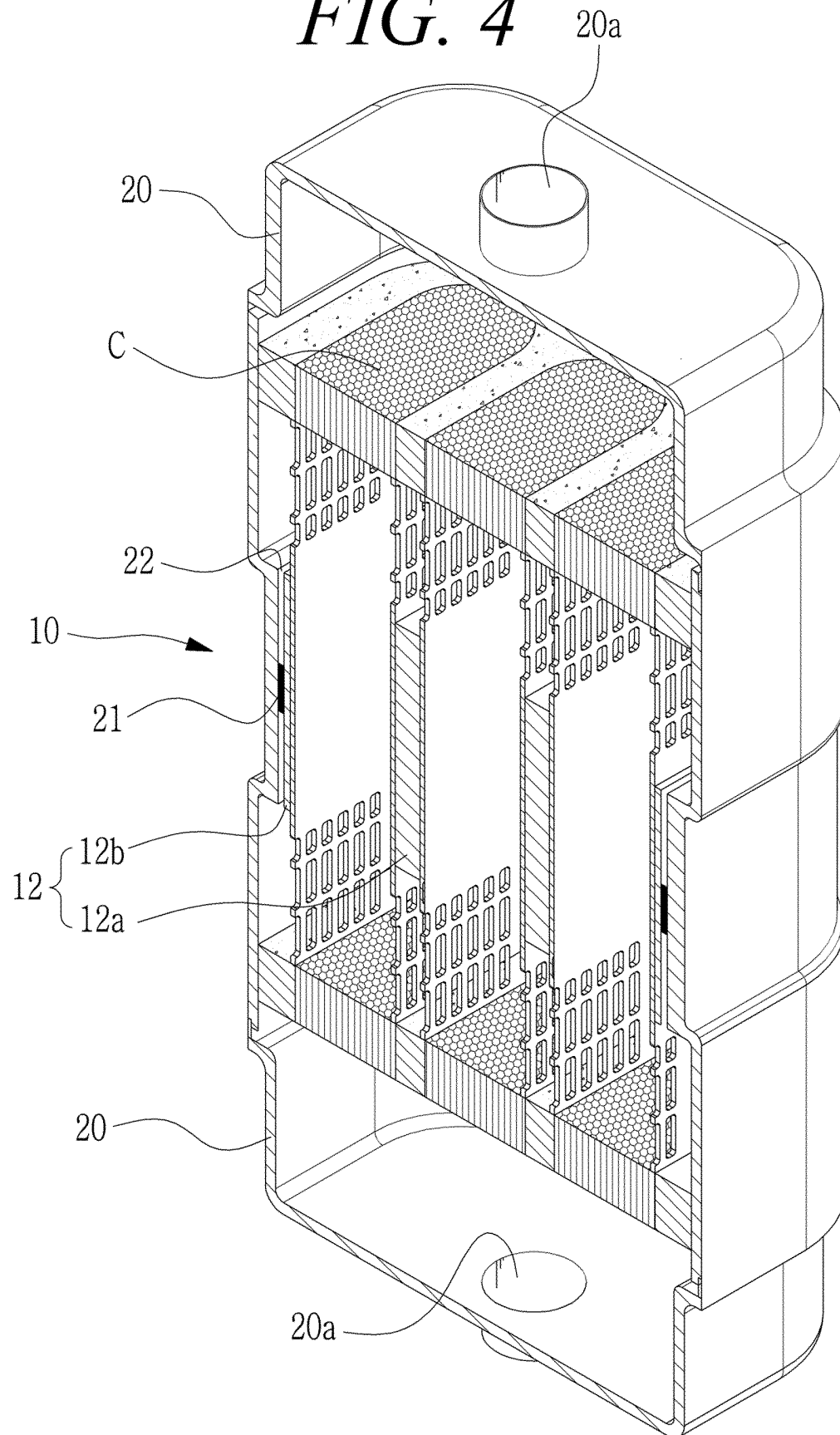


FIG. 5A

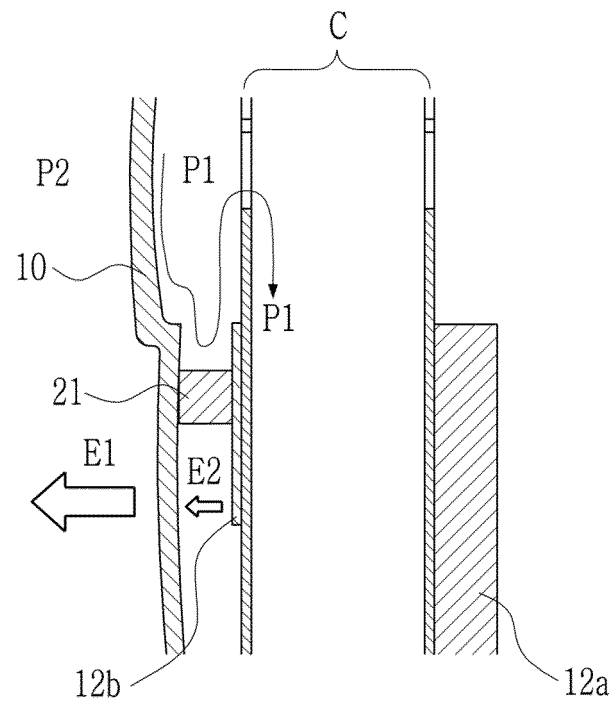


FIG. 5B

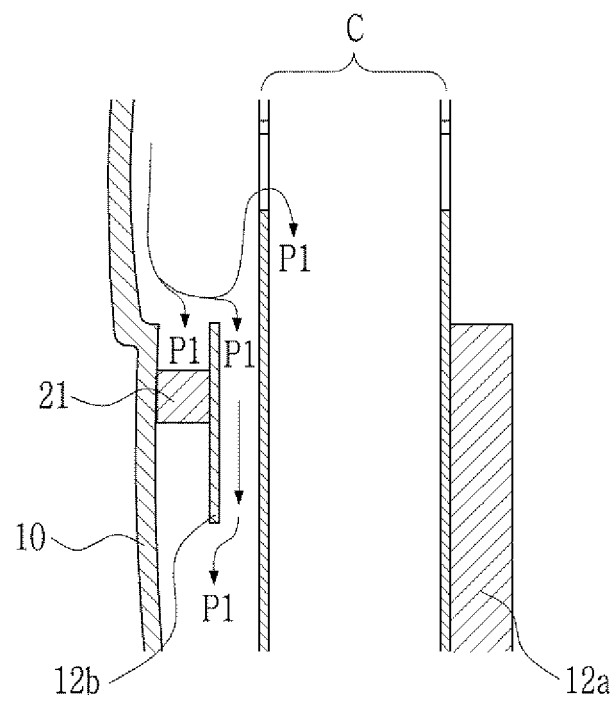


FIG. 6

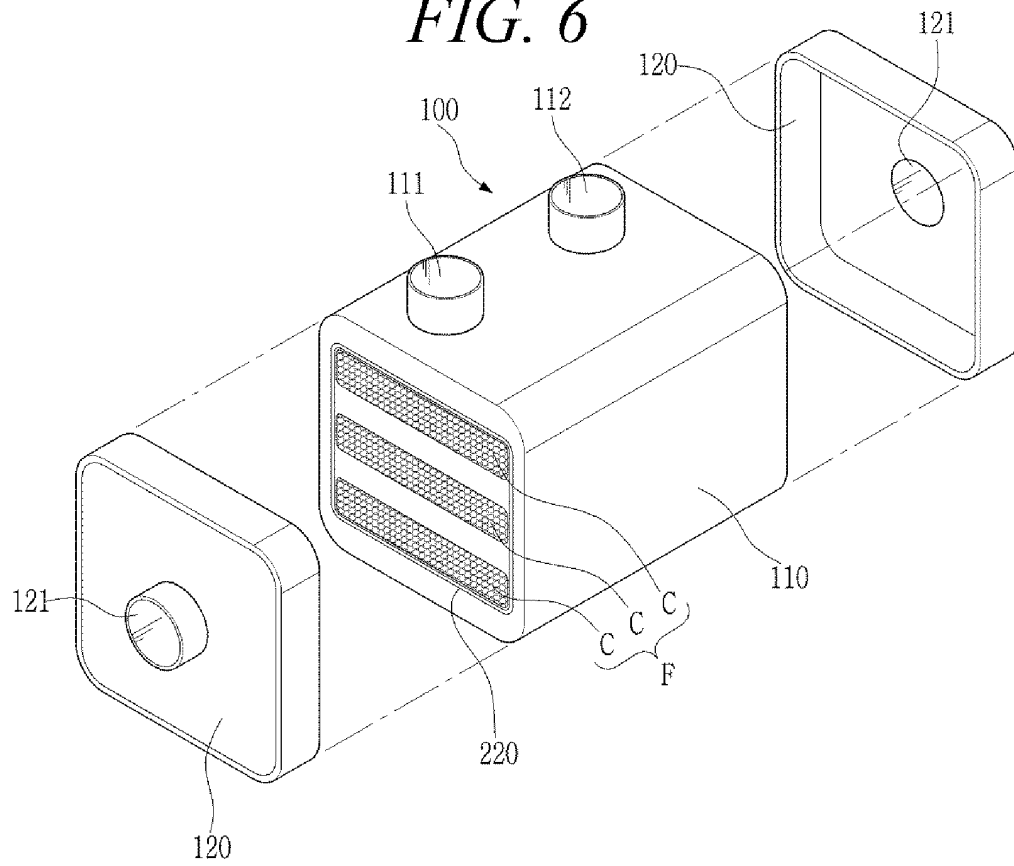


FIG. 7

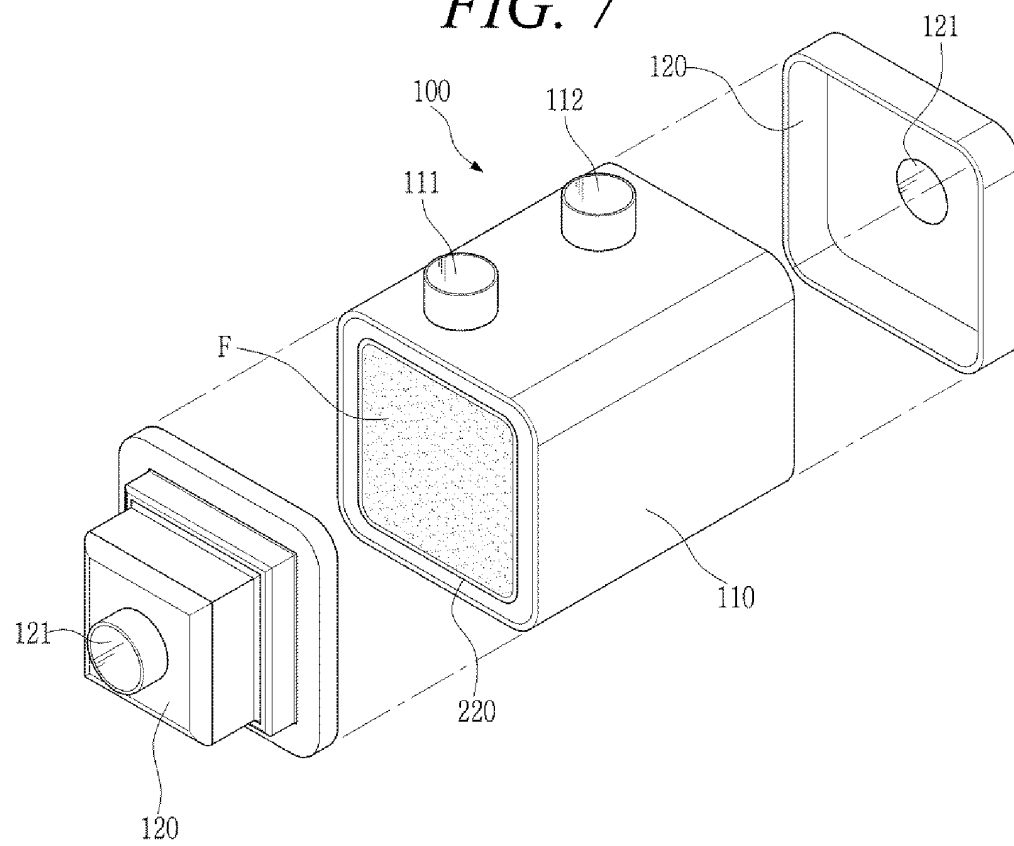


FIG. 8

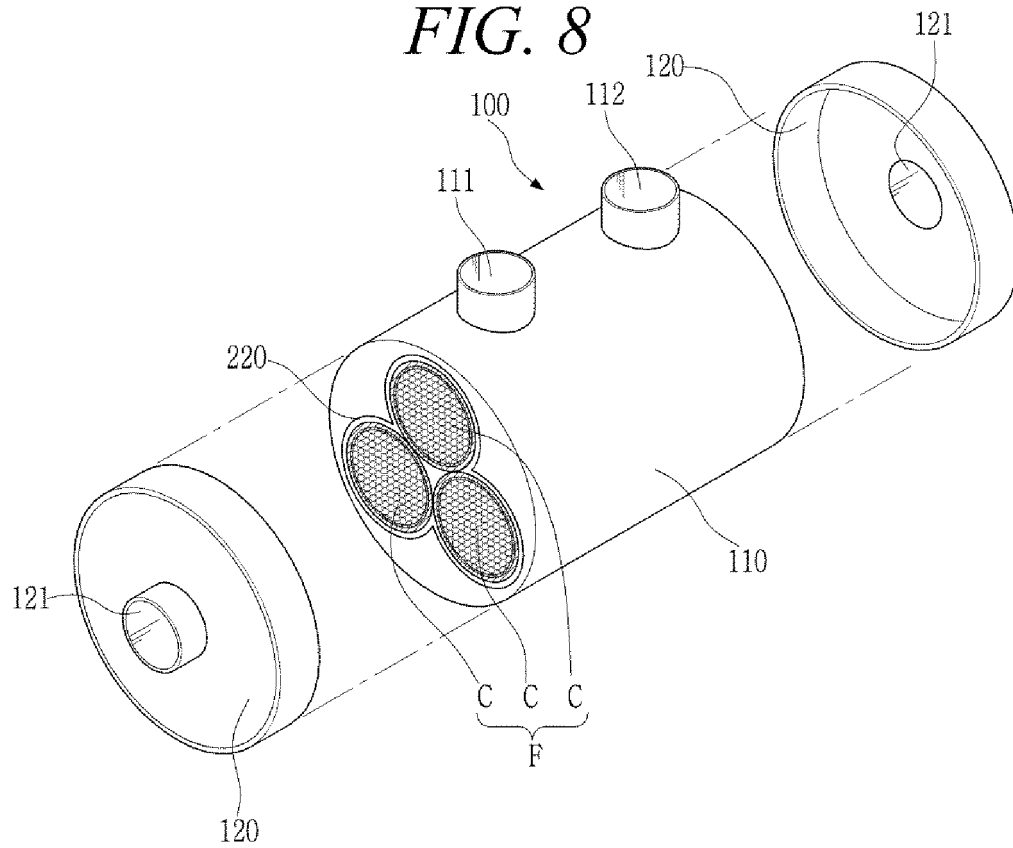


FIG. 9

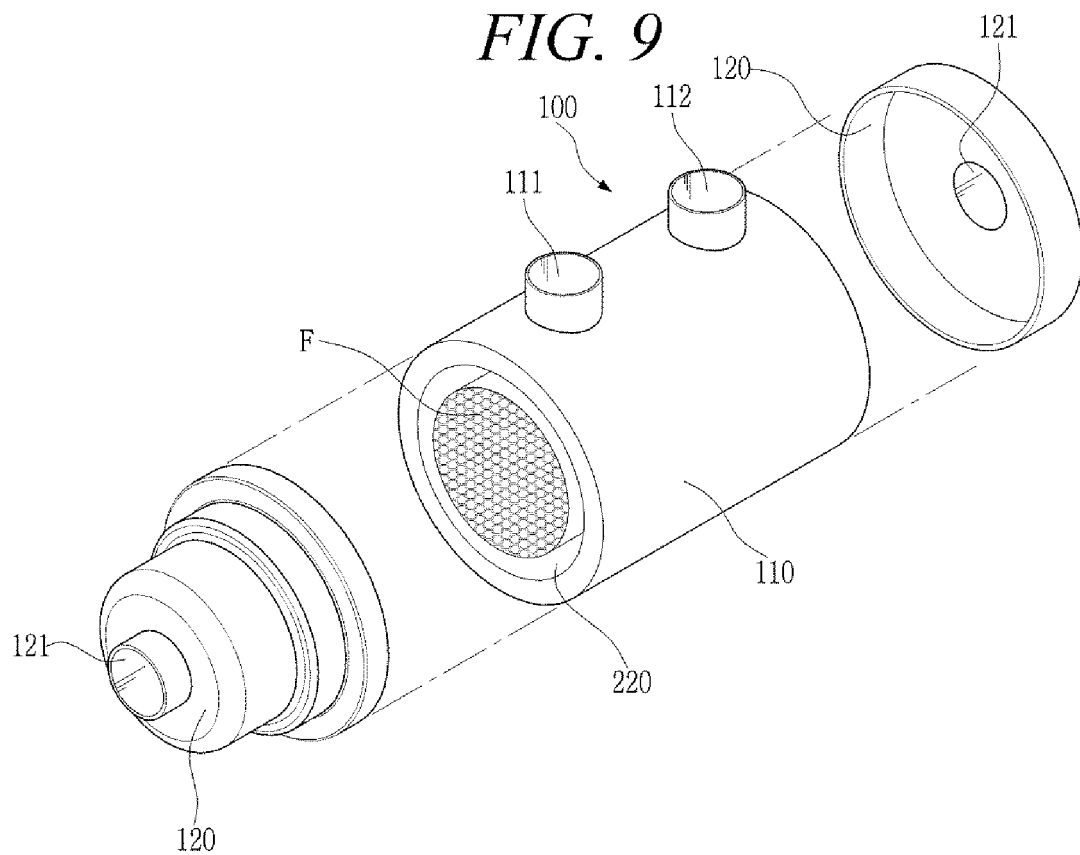


FIG. 10

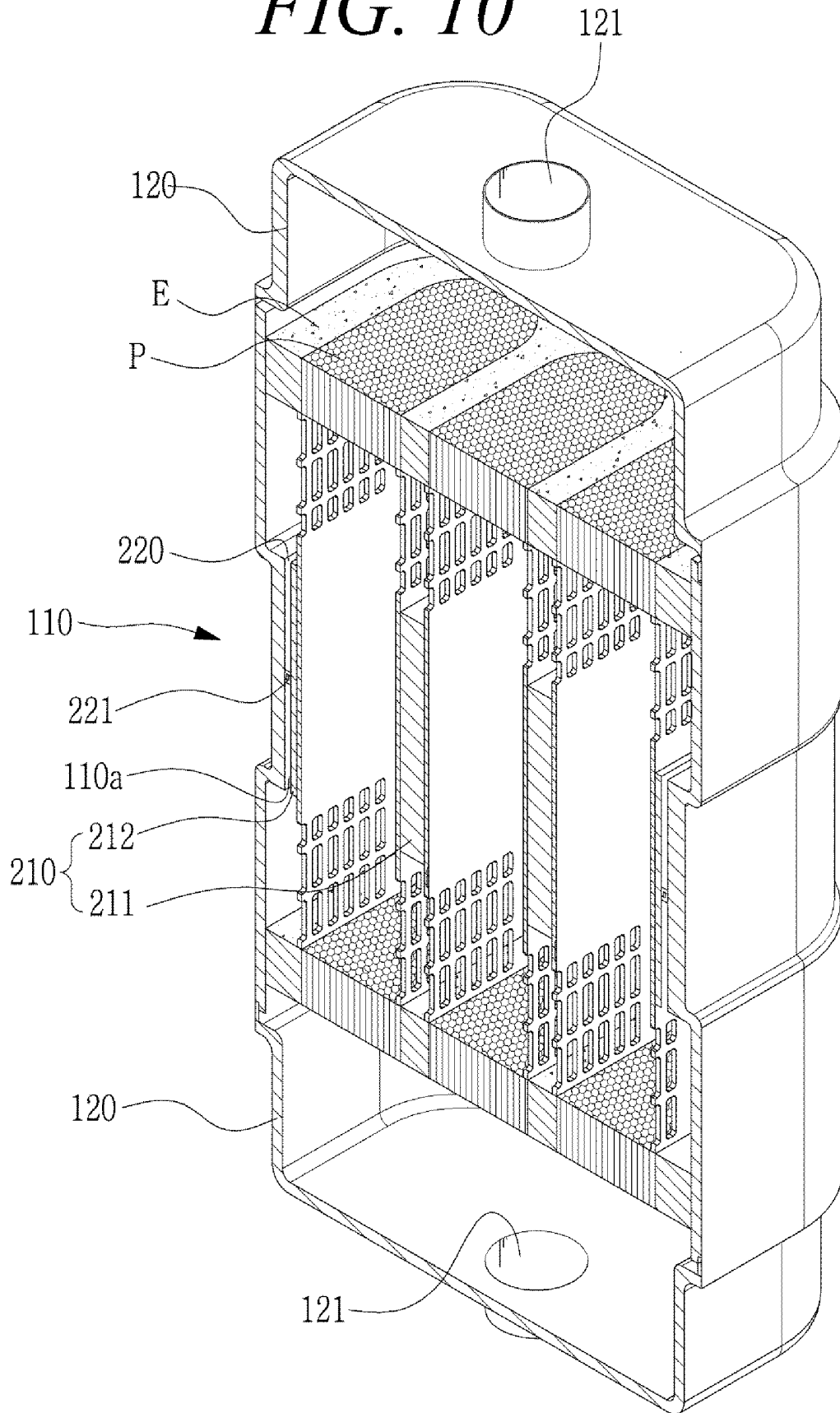


FIG. 11

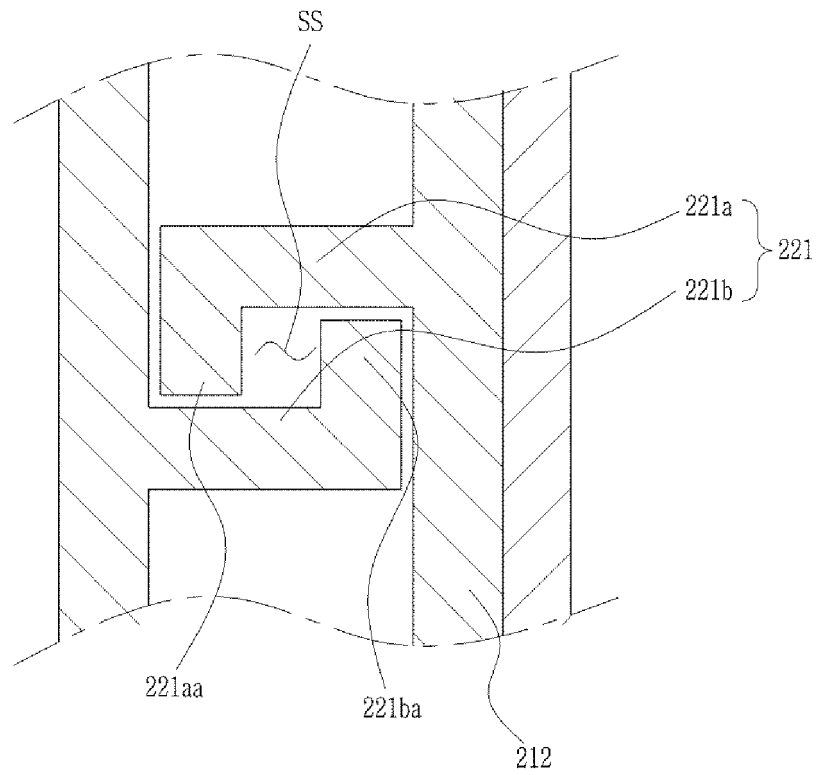


FIG. 12

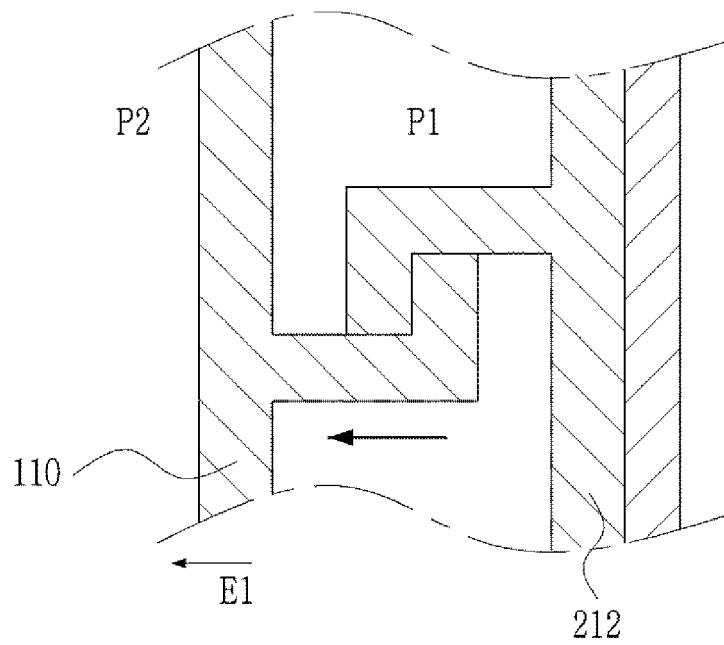


FIG. 13

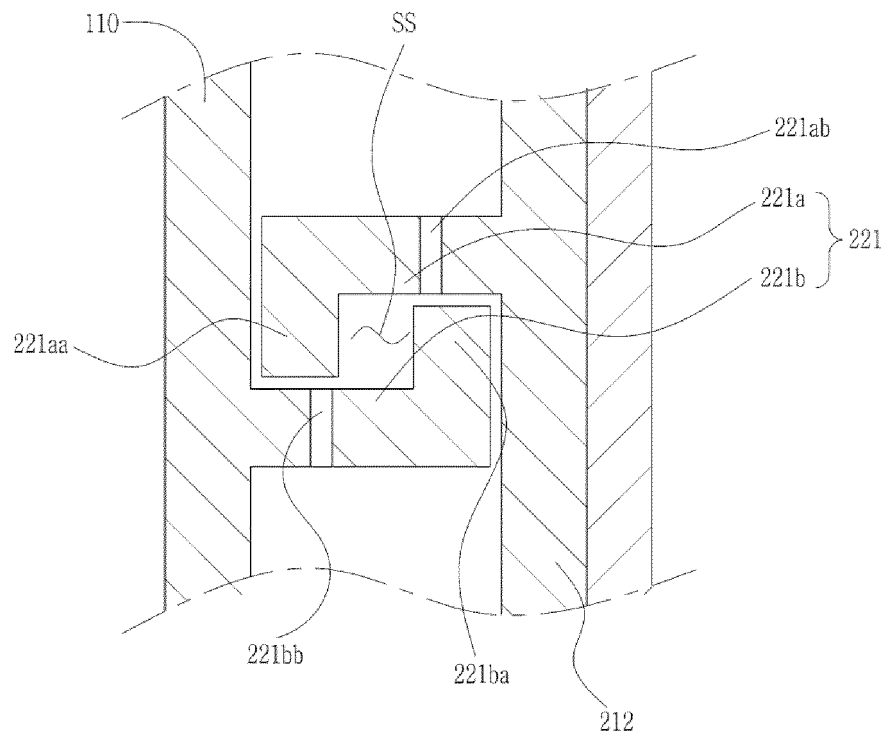


FIG. 14

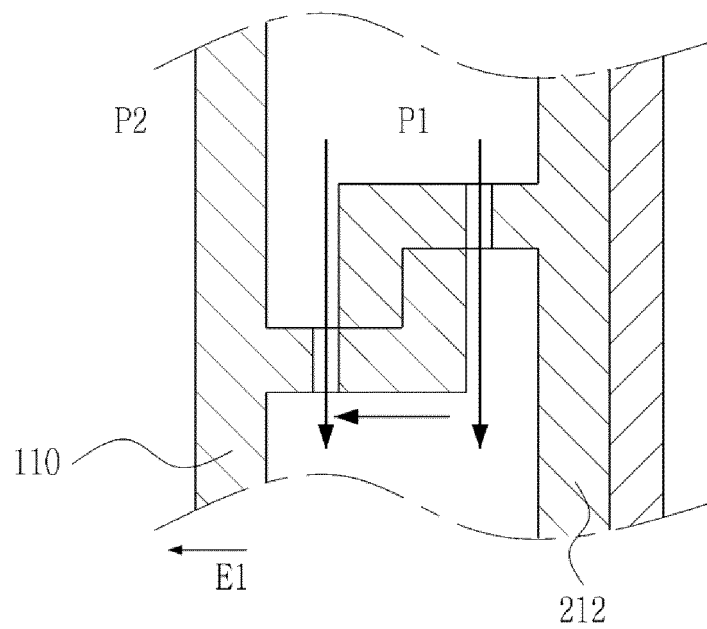
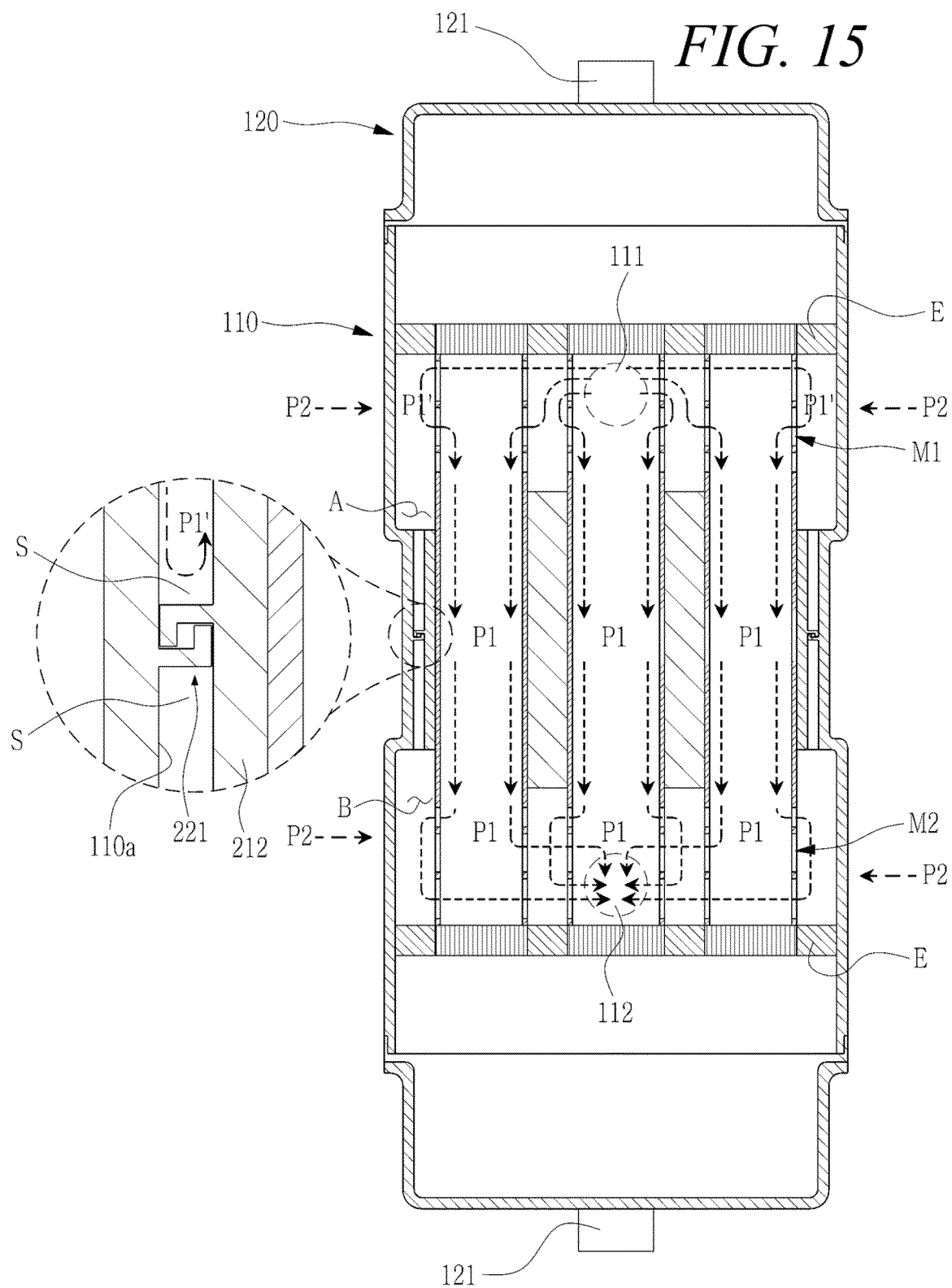


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/095017

A. CLASSIFICATION OF SUBJECT MATTER

H01M 8/04119(2016.01); B01D 63/02(2006.01);

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01M 8/04119(2016.01); B01D 63/02(2006.01); B65D 45/16(2006.01); B65D 6/24(2006.01); H01M 8/04(2006.01);
H01M 8/04089(2016.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS (KIPO internal) & keywords: 연료 전지(fuel cell), 가습막(humidification membrane), 중공사막(hollow fiber membrane), 배가스(off-gas), 압력 버퍼(pressure buffer), 압력 차이(pressure difference), 고압(high pressure), 팽창(expansion)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2186188 B1 (KOLON INDUSTRIES, INC.) 03 December 2020 (2020-12-03) See paragraphs [0007], [0010], [0013], [0016] and [0021]-[0023]; and figures 1a and 2a.	1-8
A	KR 10-2018-0037390 A (HYUNDAI MOTOR COMPANY) 12 April 2018 (2018-04-12) See entire document.	1-8
A	KR 10-2020-0056714 A (LG CHEM, LTD.) 25 May 2020 (2020-05-25) See entire document.	1-8
A	US 2014-0162150 A1 (HYUNDAI MOTOR COMPANY) 12 June 2014 (2014-06-12) See entire document.	1-8
DA	KR 10-2019-0138288 A (KOLON INDUSTRIES, INC.) 12 December 2019 (2019-12-12) See entire document.	1-8

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 May 2022

Date of mailing of the international search report

16 May 2022

Name and mailing address of the ISA/KR

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Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/KR2022/095017

C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	WO 2021-107679 A1 (KOLON INDUSTRIES, INC.) 03 June 2021 (2021-06-03) See claim 1; paragraphs [0041], [0042], [0054] and [0055]; and figures 3, 4 and 7-9.	1,8

Form PCT/ISA/210 (second sheet) (July 2019)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/KR2022/095017

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		EP 3806211 A1	14 April 2021
		JP 2021-524133 A	09 September 2021
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REFERENCES CITED IN THE DESCRIPTION

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